Space Weather Technical Forecast

Issued on Thursday, 28 September 2023 at 13:30 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Ongoing chance of isolated M-flares (R1-R2 Radio blackouts). A chance of Active electron fluence on Day 1 and 2 (28 and 29 Sep) and a chance of G1-G2 (Minor to Moderate) geomagnetic storms on Day 4 (01 Oct).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has increased to Moderate levels. The largest flare was an M1.2 flare at 28/0907 UTC from AR3450 in the far southeast.

There are currently eight sunspot regions on the visible disc, with five of these located in the western hemisphere. The most magnetically complex group lies in the northeast quadrant (AR3449), which has developed penumbra on both ends of the group with some intermediate spots. Previously more active groups such as AR3445 in the southwest have shown signs of slight decay, with a weakening of the trailing spot. AR3450 in the far southeast has been the most active region, responsible for the recent low-level M-flare. There is still significant foreshortening of the group in available coronagraph imagery, but it appears to be an open, bipolar group with an asymmetric lead spot. All other regions are small and/or magnetically simple at this time.

No potential Earth-directed CMEs have been observed in the past 24hrs.

Solar Wind / Geomagnetic Activity: Solar winds as observed at DSCOVR/ACE has shown a general, but erratic decline during the period, falling from 400-450km/s to around 370km/s. Peak winds of 507 km/s were observed at 27/1945 UTC. This increase may have been the result of some brief reconnection to CH50/-. Density was largely below average. The Interplanetary magnetic field (IMF), Bt, was weak between 2-6nT, with the north-south component (Bz) also weakly variable (ranging from +5nT to -5nT. Phi angle was largely positive (away from the Sun). Resultant geomagnetic activity was Quiet to Unsettled (Kp0-3).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at background levels. GOES16 high energy (greater than 2MeV) electron flux was at Moderate to diurnally High levels, with a peak of 3760 pfu at 27/1620 UTC. Associated 24-hour fluence was just below the Active (1e8 integrated pfu) threshold, on a steady trend. The observation at 28/0001 UTC was 7.41e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Activity is expected to remain at Low to Moderate levels, with further isolated M-class flares possible, mainly from the active regions in the eastern hemisphere.

Solar Wind / Geomagnetic Activity: A possible glance from weak CME arrivals cannot be ruled out on Days 1 and 3 (27 and 29 Sep), however this is deemed very low confidence. Otherwise no CMEs feature in the current forecast period.

Solar winds are currently at background levels, perhaps increasing to Slightly Elevated speeds between Days 1-3 (28-30 Sep) due to minor coronal hole influences. A more significant, recurrent coronal hole (CH54/+) is anticipated to arrive at Earth from Day 4 (01 Oct) or perhaps the following day.

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Met Office Space Weather Technical Forecast

Geomagnetic activity is expected to be largely Quiet to Unsettled, with a slight chance of Active intervals on Day 1 (28 Sep) and on Day 3 (30 Sep). From Day 4 (01 Oct) activity may increase to Unsettled to Active levels with a chance of G1-G2/Minor-Moderate Storm (Kp5-6) intervals.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to remain at Background levels, with a daily very slight chance of an enhancement should any larger flares occur.

High energy electron flux (greater than 2MeV) is likely to see day-on-day reductions in peak values from Moderate to High, becoming Moderate to background later in the period. The associated 24 hour fluence is just below the Active threshold, with a chance of exceeding this on Days 1 and 2 (28 and 29 Sep) with the risk markedly reducing in the following days.

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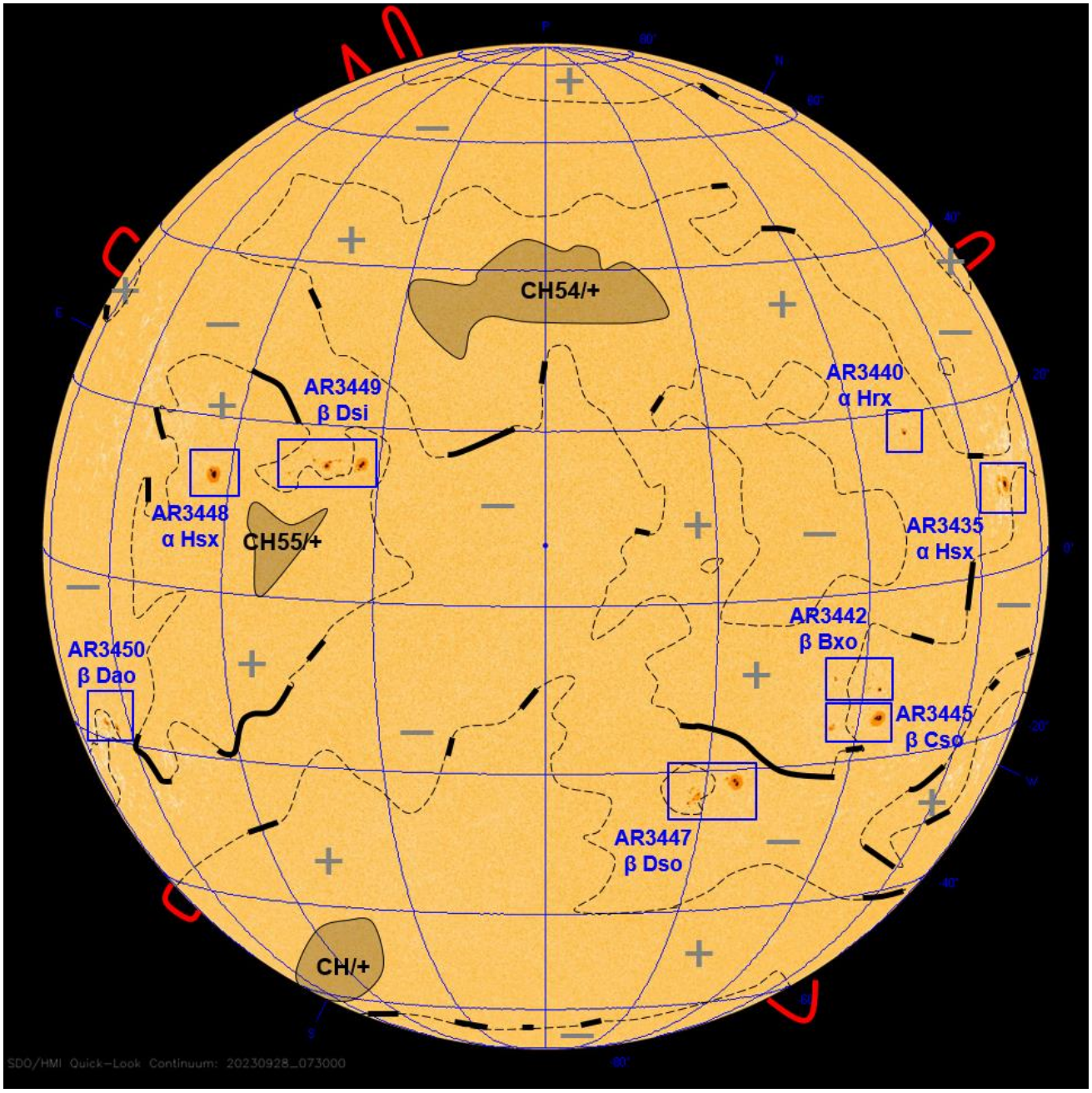
Figure 1. Solar Analysis Valid 28/0630 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are two CMEs in the forecast, both considered a very low probability of causing a glancing blow at Earth. The first was from a filament eruption from the western limb on 24/1554 UTC, with a possible glancing blow on Day 1 (28 Sep). The second was from another filament eruption from the northwest quadrant on 25/1540 UTC. Analysis of this CME was tricky with a lack of available imagery due to spacecraft manoeuvres, with a very slight glancing blow late on Day 2 (29 Sep) deemed possible. In all likelihood, these two CMEs will both pass ahead of Earth, hence any impacts are deemed very low confidence.

Solar winds are currently at slow-ambient levels. Some minor coronal hole enhancement is possible on Day 1 or 2 (28 or 29 Sep), perhaps increasing speeds to Slight Elevated levels (around 400km/s). Otherwise, the next recurrent HSS is expected from northern hemisphere CH54/+, either late Day 4 (01 Oct) or the following day. Speeds should increase to Slightly Elevated to perhaps Elevated levels, just outside the end of the current forecast period.

Geomagnetic activity is expected to be largely Quiet to Unsettled, with a slight chance of Active intervals on Day 1 (28 Sep) and on Day 3 (30 Sep) due to any minor glancing CME effects. A further enhancement is possible from Day 4 (01 Oct) with any connection to CH54/+, giving a chance of Active (Kp4) to G1-G2/Minor-Moderate Storm (Kp5-6) intervals.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	1	5	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections – Nil expected.

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Radio Blackouts - X-Ray Flares:

Solar activity has increased to Moderate levels. The largest flare was an M1.2 flare at 28/0907 UTC from AR3450 in the far southeast.

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Far-sided seismic data suggests a large active region is due to rotate over the northeast horizon on day 4 (01 Oct). This may counteract the loss of AR3435 and AR3440 that will rotate over the western limb in the coming days.

Activity is expected to remain at Low to Moderate levels, with further isolated M-class flares possible.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	25	25	25	25
Very Active	R3 to R5 X Class	No	1	1	1	1

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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is likely to persist at background levels, however with five active regions moving across the western disc there is a very slight chance that any significant flares could produce an S1 or greater event.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) observed by GOES16 is varying between mainly Moderate to High levels on a diurnal cycle. Moderate to High diurnal peaks in electron flux are likely on Day 1 and 2 (28 and 29 Sep), however any further minor CME glancing blows may see the electrons suppressed once again, but this is considered very low confidence. More persistently Moderate to background levels are expected from Day 3 (30 Sep).

The associated 24 hour fluence has been on a steady trend just below the Active threshold. The diurnal High peaks in electron flux mean there is a chance that we see the associated 24 hour fluence rise above the Active threshold on Day 1 and 2 (28 and 29 Sep). The risk reduces in the following days as electron flux reduces. REFM output suggest an exceedance of the Active threshold on Days 1 and 2, though is currently forecasting fluence values above those observed.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	40	30	10	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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Figure 2: GOES16 >2MeV Electron Flux (above) and MOSWOC REFM output (below)

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